



## A Perspective on System Engineering – Delivering Capabilities



Briefing to Air Force Studies Board  
9 Jan 2007  
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Chair, SE Programs



## AF CSE Focus



- **Process Improvement**
  - Tools Development
  - Research and Application
- **Rotational program**
- **Academic programs**
  - Graduate programs – MS, PhD & certificate
  - Intermediate Developmental Education (IDE) Program
  - Professional Continuing Education (PCE)
  - Seminars, workshops, short courses
  - Outreach--provide accessibility at key locations
- **Case studies**

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## Systems Engineering Case Studies\*

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**C-5 Galaxy**



**B-2**



**F-117 Aardvark**



**Hubble Space Telescope**

Currently available case studies  
provide good and bad examples  
of pre-acquisition activity  
- New cases underway



**TBMCS (Theater Battle  
Management Core Systems)**



**JASSM (FOUO)**

\* Available at:  
[www.afit.edu/cse/](http://www.afit.edu/cse/)

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## The Challenges

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- **Policy**
  - Policy alone will not solve current problems
  - Valid measures of success needed
- **Tools**
  - Exist, but not always used and understood
- **People**
  - Insufficient expertise for pre-acquisition activities in both requirements and acquisition communities

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## Related Policy Initiatives

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- **Joint Capability Integration & Development System**
  - Responsible for developing, approving capability documents
  - Implementation still troublesome after 3+ years
- **DoD Architecture Framework**
  - A tool, not a method or solution by itself
  - Many building architecture products, few using integrated architectures
- **OSD Concept Decision/Evaluation of Alternatives Initiative**
  - Attempting to address problems with transition from JCIDS to Acquisition
  - Combining Analysis of Material Approaches (AMA) with Analysis of Alternatives (AoA) prior to Concept Decision

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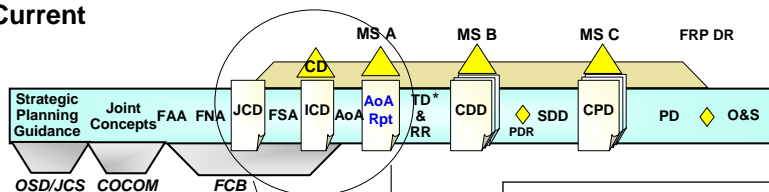


## DoD Capability Development

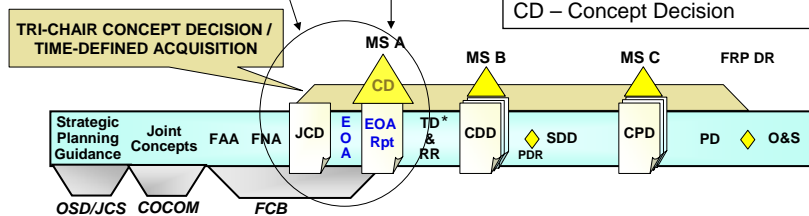
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### Current



### OSD CD/EOA Initiative



FSA – Functional Solutions Analysis  
EOA – Evaluation of Alternatives  
JCD – Joint Capabilities Document  
ICD – Initial Capabilities Document  
CD – Concept Decision

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## OSD CD/EOA Pilot Program



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### ■ Cautionary Notes:

- Combined FSA & AoA still needs solid foundation from JCIDS FAA & FNA
- Not clear who is responsible for “doing” the EOA
- Combined FSA & AoA must address full range of joint concepts to achieve mission capability



## Capability Development – Tools



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- System Architecture
  - Most “architectures” are sets of disjoint “products”
  - Must be integrated with other analytic tools
- Modeling and Simulation
  - Fidelity must be tied to analysis questions
  - Discrete event simulation useful for architecture analysis and evaluation
- Other analytic methods
  - Utility theory – often used, underlying assumptions rarely stated or understood
  - Queuing theory – useful for evaluating architectures
  - Optimization – extremely valuable for exploring trade space
- Cost estimation
  - Insufficient parametric and analogy based cost estimation expertise



## Capability Development – People

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### SE process implemented by distinct communities:

#### ■ Acquisition Personnel – Typical Focus

- Ongoing challenges associated with aging acq. workforce
- Need continued focus on growing personnel with relevant technical backgrounds
  - Concerns for Engineering Technology vs. Engineering degree
- Need more incentives/opportunities for pursuing technical MS

#### ■ Requirements Personnel – Often Overlooked

- Lack sufficient personnel with relevant technical backgrounds
  - Accession system does not identify needs for technical operators
  - Few incentives/opportunities for pursuing advanced technical education
  - Especially problematic within space community

**The communities responsible for capability development do not have the requisite numbers, background and toolset!**

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## SE Education Opportunities

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#### ■ AFIT has significantly expanded offerings and accessibility of SE programs

- 12 month resident MS program for AF IDE selects
  - New PhD program
  - Traditional thesis based MS program is now available for part-time students via Distance Learning (DL)
  - Graduate certificate program available for part-time students via DL
  - Continued expansion of DL sites planned, but depends on tuition funding by AF organizations
- #### ■ Collaborative agreements with civilian universities in place at several locations and possible at others

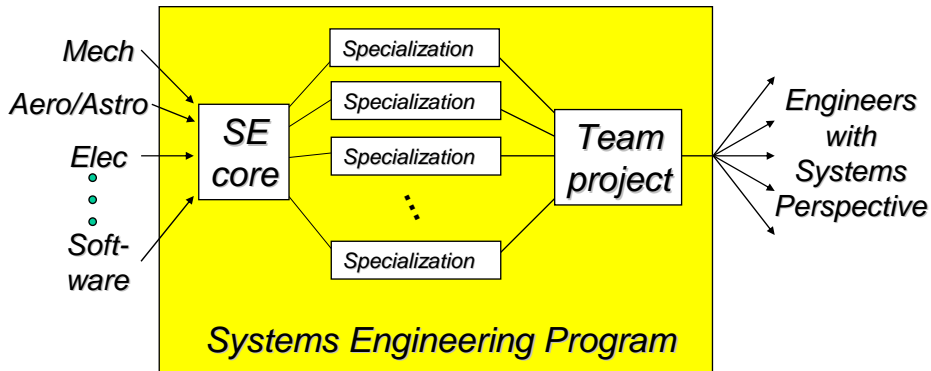
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# AFIT SE Programs

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1. Core courses cover process, method, and tools applicable throughout the life cycle, **with emphasis on Pre-A/B activities.**
2. Individuals with non-technical BS degrees may be admitted, but generally require math and other preparatory courses in addition to MS program requirements

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## Pre-A SE Research and Application

Relevant Research and Engineering Applied to AF/DoD Problems



### Sponsored Projects by:

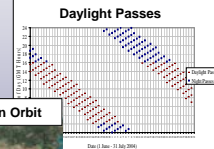
Air Force Research Laboratory  
Air Combat Command  
Air Force Special Operations Command  
Air Force Space Command  
National Reconnaissance Office  
Joint Forces Command  
Aeronautical Systems Center  
Air Force C2ISR Center Center  
505th/705th Training Squadrons  
Air Armament Center  
Air Staff and others



Ritchey-Chrétien Optical Telescope

### Student Thesis – Mar 05 Sponsor – AFRL/VS

- TACSAT operational utility
- Logistics impact



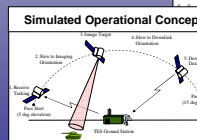
### Match Student Experience to Capstone Project (4-6 students)

### SE Student Pool

Pilots  
Intelligence  
Space Operators  
Maintainers  
Acquisition  
Civil Engineering  
Computer  
Communications  
Testers  
Sustainer



### Matched Inclination Orbit



**Can Provide Systems Analysis, Trade Studies, Design,  
Operations Concept and Requirement Analysis in 3-9 months!**

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## AIR FORCE CENTER FOR SYSTEMS ENGINEERING ANALYSIS OF NEAR SPACE VEHICLES (NSV) FOR THE MISSION OF PERSISTENT ISR

Research Sponsor: National Reconnaissance Office  
Maj Jack Allen, Maj Steve Buzon, Maj Brian Miller, Maj Scott Wierzbanski



### Methodology

- Derived applicable threads via Future Concept Documents
- Determined appropriate MOP's/MOE's for derived threads
- Analyzed Capabilities, DOTMLPF, Risk/Feasibility
- Developed application to compare NSV alternatives

### Traceability to

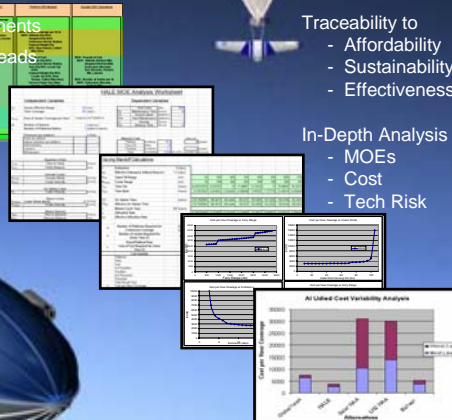
- Affordability
- Sustainability
- Effectiveness

### In-Depth Analysis

- MOEs
- Cost
- Tech Risk

### Results

- Global Hawk → HALE
- HALE UAV
  - Low cost
  - Maturing technology



## AFIT SE Graduate Assignments

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- IDE Graduates ideally suited for Joint Staff, MAJCOM and Unified Command jobs
  - Requirements (J8, AF/XOR, ACC/DR, AFSPC/DR, J3 Ops/Plans)
  - Warfighter Integration (J6, AF/XC)
  - Program Element Monitor (SAF/AQ)
  - Advanced Planning and Program Offices
- Feedback from graduates and supervisors indicate direct application of SE in follow-on assignments
  - “I’m working on a new information operations capability for USSTRATCOM; building a new Capability Development Document (CDD)—just thought you would like know I’m one more example demonstrating the SE Program IS preparing IDE students for their next job as tasked by SECDEF”
  - Graduate at AF/XOX – “I find myself producing, maintaining and reading architecture products to support AF CRRA process ... I’m using utility theory to weight systems, capabilities, activities and tasks for overall assessment ... all things I studied at AFIT!”
  - AFMC SES having difficulty hiring architects with DoD perspective; “sounded like a perfect match for AFIT IDE people to me”

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## Professional Continuing Education (PCE)



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- **Excellent way to reach large numbers of both broad and targeted audiences**
  - Provides familiarity, not expertise
- **17 Systems Engineering Courses Currently Available**
- **5 Courses in Development**
  - **AFIT**
    - HSI 161 – HSI Requirements Generation
    - HSI 260 – HSI Implementation in the Acq Process
    - Critical Safety Items
  - **AFMC/EN**
    - Systems of Systems Engineering
    - Systems Engineering Plan Writing
- **20+ Additional Courses have some SE content**
- **Course Management**
  - AFIT is the PCE Course Administrator
  - AF Center for Systems Engineering evolving to single focal point for SE

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## SE Education Concerns



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- **Accession system not addressing technical needs**
- **AF has cut back significantly on resident graduate opportunities**
  - AFIT IDE program now at 43 students (FY07) from high of 220 (FY05)
    - Fewer opportunities for operators to get relevant technical degree
  - Overall AFIT quotas now down to pre-2002 levels
  - Example: Turkish AF now sends as many students to AFIT for graduate space education as the USAF!
- **Policy alone will not solve the problem**
  - AF needs technical operators as well as skilled acquisition and sustainment personnel

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## Summary



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- SE policy without addressing personnel needs will not solve problems
  - Workforce initiatives associated with Pre-Milestone A activities must include both the requirements and the acquisition community
- SE toolset exists, but needs wider dissemination and understanding
- Expanded SE education – to include more requirements personnel – could be the biggest payoff
  - Large draw-downs in AFIT IDE students are hurting efforts
  - AF organizations struggling to resource part-time students in local, DL programs

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## Questions ?



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